Overview of thermal infrared remote sensing

Anne B. Kahle[1]

Both high spatial resolution and multispectral capability in wavelength range (3-14 µm) are required for a number of important scientific, operation and commercial applications.

The basic physical variables that are determined from these measurements are surface temperature, and surface spectral signatures, both of which are a function of type and condition of surface materials present. Accurate land surface temperature can best be derived remotely if one has multispectral data, which will allow for the calculation of first the emissivity and then the temperature. The spectral emissivity will vary as a function of surface substrate, and (as a function of time) with amount of vegetation present and with soil moisture.

High spatial resolution data is required both for the measurement, monitoring, and early detection of changes of the land surface at a scale of human activities and for determining physical processes that occur at this scale. Since the Earth's surface is heterogeneous over a large range in spatial scales, including 10s and 100s of meters, it is important that the satellite remote sensing data in the thermal infrared bands correspond to these smaller scales. Building up values for accurate and reliable large scale fluxes and scalar products requires the synthesis of smaller scale values — in essence, creating a mosaic of high spatial resolution pixels for sensible and latent heat flux, and soil moisture.

Knowledge of the Earth's land surface energy and water balance is an important element in understanding the dymamics of global and regional changes in the environment. High spatial resolution, thermal infrared measurements provide important inputs for algorithms that calculate surface energy and water fluxes. Also, the correlation between near-surface soil moisture content and surface temperature can be used in conjunction with other remote sensing and in situ data to estimate changes in soil moisture. Other applications which require high spatial resolution temperature include such diverse studies as monitoring of volcanoes, geothermal areas, and wildfires, determination of cloud top temperatures (and thus indirectly cloud top height), vegetation water stress, wetland extent, evapotranspiration, snow melt conditions, coastal studies, and determination of thermophysical properties such as thermal inertia.

In addition to being required for accurate temperature determination, the emissivity data will also be used for geological studies of a scientific and commercial nature, including stratigraphic and structural mapping and mineral exploration, for soil mapping and for studies of soil degradation and land use change, and for hazard monitoring and mapping. Because multispectrtal thermal infrared data have not been generally available in the past, the user community is only just becoming aware of their potential. When data from ASTER become available, we anticipate that many new and innovative uses will be developed.

[1] Jet Propulsion Laboratory, Pasadena, CA